

Heavy Metal Poisoning resulting from Double Agenda Management in (Gold-)Mining of Western Region Ghana

J. B. Pronk, Ghana Medical Association / Cross-Africa Irrigation Organization, c.q. African E.P.A., i.s.n. (in being), tel. +233-263934775

This is at the Core of Water Pollution:



- II. Purpose of this paper:**
- 1. To advise authorities - officials, lawyers, and environmental managers on heavy metal poisoning measures.
 - 2. To propose and discuss prevention strategies for HM contamination.

- II. Index**
- 1. Introduction to a conflict-of-interest problem;
 - a. Survey on environmental impact of galamsey activities;
 - b. Survey of stakeholders in galamsey activities;
 - c. Survey of anti-corruption research in the Water Management.
 - 2. Relevant Statistical Studies (in Western Region of Ghana) on Heavy Metals contamination of surface- and ground-water, in Tarkwa;
 - 3. Systemic Approach of the Issues at hand;
 - a. The Ghana Environmental Law concerning Water, The applicable law;
 - b. The Ghana Environmental Policies concerning Water;
 - c. Summary Ghana's Water & Sanitation Crisis - water.org.
 - 4. My Comments to those studies;
 - a. Why the Title: 'Double Agenda'?
 - b. Drainage in River-systems from main Gold-Mines in Ghana;
 - c. The Role of the Drinking-water Sector Organizations in water management;
 - 5. Conclusion.

- 5a. What has priority to be corrected or cleansed up?
- 5b. The way forward:
 - A. The Classical Gold Extraction Process;
 - B. Examples of Toxic-free chemical Gold-Extraction Methods in use
 - C. Chemical-free methods of Gold-Extraction in use
- 6. Epilogue.

1. Introduction:

To introduce you to the complexity of pollution of water by Heavy Metals, and how you may be confronted with it in daily life, you will recognize how farmers in Africa reacted to this problem. Farmers complained that Chinese workers and managers left the agricultural fields around the Tarkwa mines in a deplorable state, after work in the Tarkwa mines, in 2015. Only by complaining this pollution came out in the news. I heard about this environmental disaster from a geologist, October 2015. And even a report in January 2016 of the C.A.C. did NOT mention this incident. Which is a shameful performance of this 'co-operation' in the light of the China-African Union Co-operation Platform (founded in the same year, when the African Union was constituted, in South-Africa, 2000).

For me, that news in 2015 was an impetus to set up a website about a Proposal for a Cross-Africa Irrigation Project, c.q. African E.P.A. (C.A.I.P.) - a comprehensive irrigation system for Africa. With URL <https://irrigateafrika.link>, since August 2021.

- . The main issue in that C.A.I.P.- Project was and still is, to deal with THE CONFLICT OF INTERESTS between
- Mining-activities with consequent Health-concerns on one hand, and

- Irrigation meeting Health-concerns: the paramount opportunities and rights for the People of Africa in Agriculture to Health-improvement, on the other hand! For Ghana, even embodied in her Constitution. In practice, however a conflict between stake-holders. In Ghana you will find an excellent example of this interaction between health, environment vs. interests in the impacts of Galamsey on 3 levels, in the Tarkwa gold-extraction area. I followed up the national and international developments of conflicting interests, since October 2015: with postings on the net. And presentations of the subject of Irrigation for Africa, Ghana (for a meeting of the G.M.A. Region, and the Metropolitan of Sekondi) (October 2019),

I needed to answer the question: how is the PRESENT state of contamination in the Tarkwa Mining area? What is happening there?

The 2015 study about the Impacts of Galamsey on Drainage and Sanitation-Tarkwa Mining communities gives an excellent idea about the complexity of the water-pollution caused by the 'Galamsey' business (AND regular gold-mining industry, where mercury is still used - and regulated - in the gold-extraction process).

1a. Impacts of Galamsey on Drainage and Sanitation-Tarkwa Mining communities [1]:

Quoted: "IMPACTS OF GALAMSEY* ON 3 LEVELS (in Tarkwa Mining Area):

- . Impacts of interference with Natural Topography and Drainage Courses:
 - by excavations, pits heaps of earth material that are continuously changing the topography and courses of drainage lines:
 - . risk of falling into pits and dying, pit collapse and mud flow or slope failures, flood and dust pollution;
 - . danger to, and destruction of nearby roads, rail lines, buildings, farms, etc..
- . Impacts of Refuse Dumping on Sanitation and Waste Management by dumping of refuse in the swamp and pits, leaching, and erosion from refuse into stagnant waters, streams, into people's houses during flooding in the raining seasons pose serious sanitation and environmental health problems:
 - . epidemic cholera, malaria, (and other) diarrhoea and skin diseases.
 - . locations of Galamsey activities within the communities are mostly inaccessible to waste collection services by the district assembly.
- . Impacts of Obstruction on Flooding (the consequences documented over the past decade include):
 - . submerging houses, roads, rail lines, schools and other structures within the flood plains and along spurs; collapse of walls, buildings and slopes, mud flow, waste flow and washing away of bridges, and loss of properties and lives, and closure of schools, roads, and other service centers."

* Galamsey: (Wikipedia) derived from the phrase " **gather them and sell** ", a local Ghanaian term.

About Mercury use in the small-mining (globally), the following facts are relevant (in 2011):

1b. Artisanal Gold Mining and Mercury Contamination of Surface Water as a Wicked Socio-Environmental Problem: A Sustainability Challenge? [2]?

- Quoted:**
- "The Facts (in 2011):
 - Artisanal gold mining (ASM) is the single largest demand for mercury in the world.
 - An estimated 1400 tons of mercury were used by ASM miners globally in 2011.
 - ASM is the largest source of mercury pollution to air and water combined.
 - Today, artisanal gold is the world's second greatest source of atmospheric mercury pollution after coal combustion, according to the UNEP.
 - And with gold prices now exceeding US\$1,600 per ounce (up from less than US\$ 500 in the 1980s), ASM is on the rise.
 - Mercury is a powerful neurotoxin that is harmful along with its mercury problem to people, but especially to developing fetuses, and young children.

- It is estimated that between 10 and 15 million artisanal and small-scale gold miners worldwide, including 4.5 million women and 600,000 children are exposed to the mercury amalgamation process.
- This process transforms elemental mercury into methyl mercury, one of the most toxic organic compounds and a powerful neurotoxin that works its way up the food chain through bioaccumulation.
- Although ASM is a long-standing component of livelihoods in West Africa, its proliferation is both unprecedented, unparalleled especially in Benin, Burkina Faso, Ghana, Mali, and Senegal.
- In part, the proliferation can be attributed to the global price of gold, which is at the highest level ever (2011).
- Mercury is the cheapest and easiest gold extraction method (my note: in 2011).
- Mercury-free gold extraction methods require more capital, training, and organization than many artisanal gold miners have access to (my note: in 2011).
- The deleterious effects of gold mining-induced mercury pollution in West African countries have, severally, been outlined. For instance, some human health impacts emanating from the use of mercury in gold mining, identified in Benin, Burkina Faso, Ghana, Mali and in Senegal.
- Yet, attempts over the last few decades to regulate ASM and its attendant mercury pollution have met pollution-human health-policy nexus; with chronic policy failure."
- Gold-winning is for 35% controlled by Small-mining industry in Ghana, whilst Ghana is top-producer of gold in Africa, and 7th on the world-list [16].

About the interested parties / stakeholders around Artisenal Small (gold) Mining:

- To Cite:** "Summary of the Stakeholder Analysis:
- Table 1 reflects the fundamental interest of various actors in the artisanal gold mining issue, and Figure 2 shows the dynamics of power at the local level in terms of the intervention strategies being implemented in gold mining communities. In this study, stakeholders, involved in ASM have been identified, as:
- Key stakeholders refer to actors who are considered to have significant influence on the success or otherwise of ASM intervention strategies.
 - Primary stakeholders are the intended beneficiaries of the strategies, while
 - Secondary stakeholders serve as intermediaries during the implementation of the ASM strategies (e.g., introduction of cleaner and alternative gold-extraction technology).
 - Active stakeholders are determinants of decision-making, while
 - Passive stakeholders are affected either positively or negatively by the decisions of others."
 - Historically significant: - 1932 Mercury Ordinance: making it illegal for Ghanaians to use mercury in mining. Still promoting illicit Galamsey gold-mining;
 - 1989 Small-scale Mining Act, making Small-scale Mining legal;

Table 1.: gives an overview of the fundamental interests of stakeholders around the artisanal gold mining issue, with categories 'stakeholder', 'characteristics', 'resource use', and 'interest';

Stakeholder	Characteristics	Resource Use	Interest
. Artisanal gold miners	Primary but passive	Disposal of untreated mining wastewater into surface water, water withdrawal & forest clearing	Economic benefits; do not pay for environmental management and remediation services; periodic use of concessions of TNCs
. Farmers, timber- and other land users	Primary but passive	Use of land for agriculture & abstraction of timber and non- and non- timber forest products	Economic benefits from continued farming and lumbering land and forest tenure
. Transnational Companies (TNCs)	Primary but active	Disposal of treated mining waste- water into surface water, water withdrawal & forest clearing, destruction of farms	Economic benefits, corporate social responsibility
. Ghana Chamber of Mines (GCM)	Primary but active	-	Economic benefits, corporate social responsibility, welfare of TNCs
. Local Government Authority	Key, secondary, active	-	Resource Governance & Ecological health of the water bodies, enactment, enforcement of by-laws
. Environmental	Key, secondary, active	-	Ecological/environmental health of the lagoon;

Protection Agency (GEPA)			enforcement of gold mining regulation and laws
.. Civil Society (Local & International NGOs)	Key, secondary	-	The ecological/environmental restoration of water; bodies livelihoods, economic, social & political empowerment of gold mining communities
- 4 Governmental Ministries:			
. Ministry of Tourism (MT)	Key but primary	forest tourism	Business/economic benefits, maintenance of aesthetics of the forest ecological zones
. Ministry of Local Government & Rural Development (MLGRD)	Key, secondary, active	-	Implementation and supervision of resource use and governance decentralization
. Ministry of Water Resources, Works & Housing (MWRWH)	Key, secondary, active	-	Formulation and co-ordination of policies and programs for Water Supply, Sanitation and Hydrology infrastructure
. Ministry of Lands & Natural Resources (MLNR)	Key, secondary, active	-	Management of Ghana's land, forest, wildlife and mineral resources

Stakeholder	Characteristics	Resource Use	Interest
- Traditional Rulers	Key, secondary, active	Cultural use of the land	Custodians & Sustenance of the cultural practice, history and beliefs associated with the land and royal Stools
. World Bank (WB) & International Monetary Fund (IMF)	Key, secondary, active	-	Funding and facilitation of natural resource & environmental governance (NREG)
. Water Resources Commission (WRC) & Forestry Commission (FC)	Key, secondary, active	-	Management of water resources and co- ordination of water policies; regulation of utilization of forest and wildlife resources, coordination of conservation policies
. Minerals Commission (MC)	Key, secondary, active	-	Ensures compliance with Ghana's Mining and Mineral Laws and Regulation
. Downstream communities	Primary but passive	Drinking surface water	Water-quality and health risk concerns

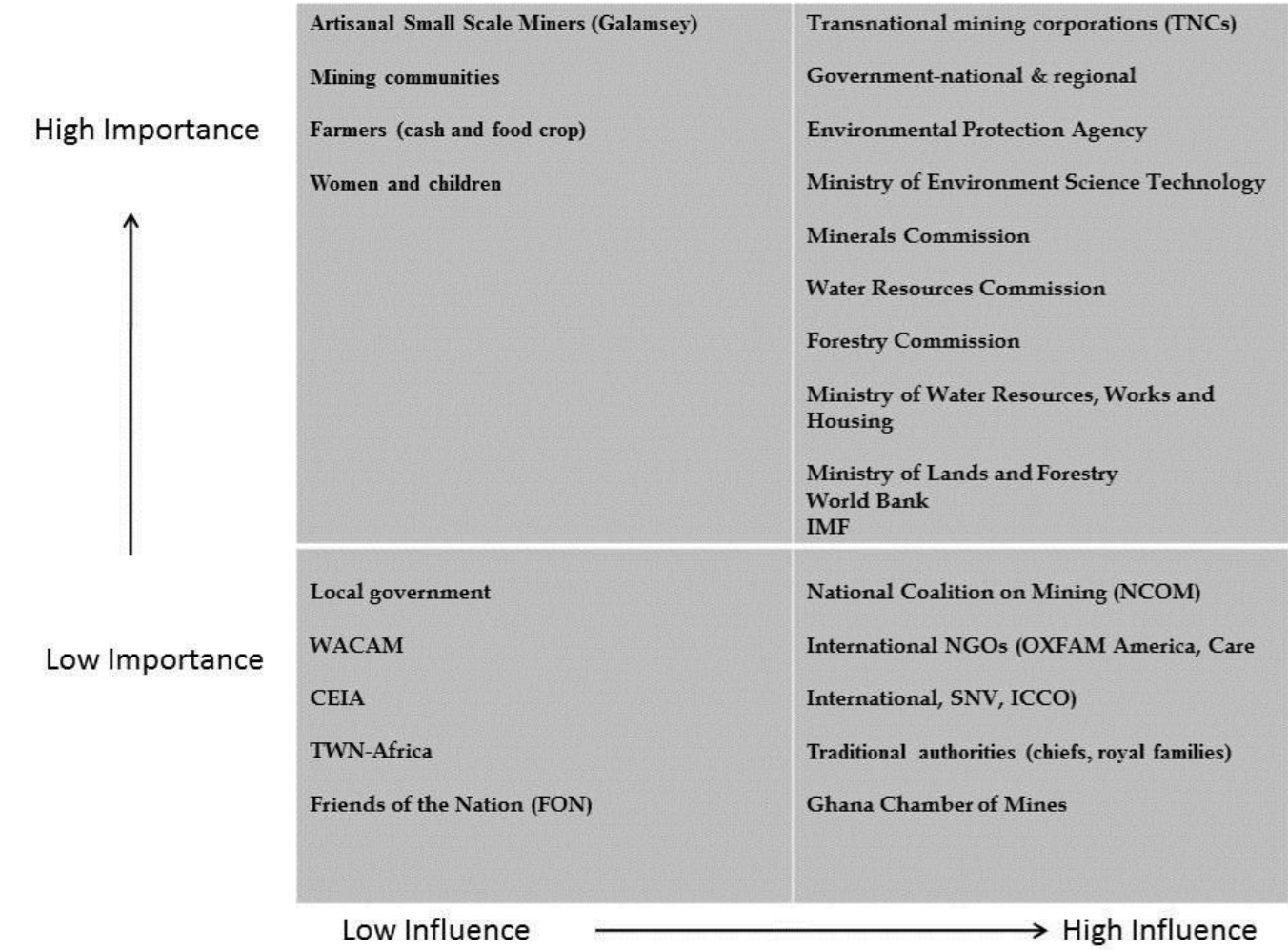


Figure 2 show the dynamics of power at the local level in terms of the intervention strategies being implemented.

1c. Anticorruption Methods & Tools W.M. UNDP-WWG (October 2011) commissioned by the UNDP, Website: www.undp.org/ [3]:

Quoted:
 “Important **drivers** for anti-corruption measures include:

- political will, related to political prestige, ideology and peer pressure;
- political will, related to downward accountability (from constituency)
- pressure to comply with transparency and integrity rules of international donors;
- mobilization of citizens (especially when they are affected directly by corruption); and
- commitment of private companies.

Important **conditions for anti-corruption measures to have positive impact include:** (in Ghana?)
 - good and fair judicial system (rule of law);
 - democratic political environment (at least to some extent);
 - free, and independent press;
 - sufficient staffing at national anti-corruption agencies;
 - civil society organizations that serve as corruption watchdogs, and have
 - adequate funding and trained staff;
 - whistle-blower protection policies and enforcement.”



Fig. 1 Excavations, Grinding and Washing of Earth Materials for Gold at Tarkwa Mining Are

2. Relevant Statistical Studies (in Western Region of Ghana) on Heavy Metals contamination of surface- and ground-water, in Tarkwa

From ending October till beginning of November 2018, I compared the research on pollution with Heavy Metals in 2010 **(A)** and 2017 **(B)**:

Ad A. The Multivariate Statistical Analysis is desirable because researchers often hypothesize that a given outcome of interest is effected or influenced by more than one thing.

- *A Parametric Data Analysis*, investigating differences: (Wikipedia) Multivariate statistics is a subdivision of statistics encompassing.
- Intended to test the simultaneous observation, and analysis of more than one outcome variable at a time. (Google).
- A collection of methods used when several measurements are made on an object in different samples.
- Popular to test quantitative data, especially of chemical analysis in mines.
- Paired and unpaired t-tests and z-tests are just other statistical tests that can be used to test quantitative data.

Ad B. The Chi-square Statistical Research is in effect
 - A Non-Para-metric Data Analysis (Google search).
 - A Univariate test: does NOT consider relationships among multiple variables at the same time. Therefore, dependencies detected by chi-square analyses may be unrealistic or non-causal. Rather, it is intended to test how likely it is that an observed distribution is due to chance.
 - It is also called a "goodness of fit" statistic (Google-search):
 - One of the most common statistical tests for qualitative data
 - the goodness of fit test: measures how well the observed distribution of data fits with the distribution that is expected if the variables are independent, so: test of independence.

A. a Multivariate Statistical Research through a cooperation between the Centre for Environmental Impact Analysis and Scientists of the University at Cape Coast was performed before February 2010, published in Research Gate [4].

Quoting “MAIN conclusions quoted:
 - Broadly, most of the water bodies in the study area have mean levels of arsenic, iron, mercury, zinc, and lead which are above WHO and GEPA guideline values.
 - High concentrations associated with high coefficients of variation, therefore, suggest anthropogenic (= by human activities caused) sources for arsenic, iron, mercury, zinc, and lead.
 - This situation makes it imperative to establish an environmental monitoring Scheme to check the concentration levels of heavy metals within the Tarkwa mining area of Ghana.”

B. a Chi-square Statistical Research (comparing expected values of variables with measured values) through a cooperation between the University of Mines and Technology in Tarkwa and the Technische Universität, Berg-Akademie Freiberg, Germany and Radford University College, Accra [5].

Quote: “Main Conclusions (quote):
 - Among the list of elements that exceeded the guideline, arsenic, manganese, nitrate, nitrite and iron were the most predominant.
 - The elevated As-levels indicate the weathering of arsenic-pyrite and the leaching of sulphur bearing mine tailings into the subsurface.
 - Results of on-site measurements and analysis of physicochemical parameters reveal that 55 % of the samples have pH values that are outside WHO’s acceptable range.
 - Efuanta and Bonsa-river: high concentrations of Fe and SO4 2- coupled with low pH, suggesting the influence of Acid Mine Drainage (AMD) on ground-water.
 - The general trend of water quality for the Tarkwa area is not as bad as previous studies have portrayed.
 - This research work together with some recent studies such as Kuma and Ewusi (2010), show that the trend of metal distribution has seen improvements in concentration levels.”
 Table 2 shows Results of Modelling with PhreeqC* showing the Distribution of Species; with categories (in columns): Mineral, Species, Samp. 3 (%), Samp. 11 (%), Samp. 15 (%), Samp. 22 (%), and Samp. 29 (%).

Fig. 15 shows a graphical Comparison of Concentration of Metals to Previous Research Works in Ground Water and Surface Water: Kortatsi in 2002, Asklund in 2005, and current research (2017).

PhreeqC = PHREEQC is a geochemical modelling software distributed by the U.S. Geological Survey and developed by David Parkhurst and Tony Appelo. PHREEQC version 3 is a computer program written in the C and C++ programming languages that is designed to perform a wide variety of aqueous geochemical calculations. PHREEQC implements several types of aqueous models

3. Systemic Approach of the Issues at hand:

BEFORE giving my (personal) opinions about the Reports in 2010 resp. 2017, I should give you a survey or the systematic approach to the problem-field.

- Strategy: most recent articles, if necessary earlier articles (as a reference);
- Method: available articles with the key-word ‘pollution of water in the Tarkwa Mining Area’;
- Categories identified (reference-categories, such as mentioned in Index Chapter 1 - 4):
 1. a. Survey on environmental impact of galamsey activities;
b. Survey of stakeholders in galamsey activities;
c. Survey of anti-corruption research in the Water Management.
 2. Relevant Statistical Studies (in Western Region of Ghana) on Heavy Metals contamination of surface- and ground-water, in Tarkwa;
 3. a. The Ghana Environmental Law concerning Water, The applicable law;
b. The Ghana Environmental Policies concerning Water;
c. Summary Ghana's Water & Sanitation Crisis - water.org.
 4. b. Drainage in River-systems from main Gold-Mines in Ghana;
c. The Role of the Drinking-water Sector Organizations in water management;

Why a ‘Systemic Approach’? You may call it a holistic approach as well, expressed in the question: How do Laws/Policies, Corruption/Fraud, Health-effects, Research in Water-pollution and River-geography INTERACT with each other? The assumption is, that this realistic approach is the BEST to arrive at practical solutions (which may be later tested in a statistical analysis as well). At first a summary of the applicable law. To summaries the categories:

Ad 3a. The Ghana Environmental Law concerning Water, The applicable law.

3a (i) 1999-8 Water Law, Water Rights and Water Supply (Africa) GHANA - country report Department for International Development (U.K.) [6]:

To CITE: “CONCLUSIONS, summarized:

1. Customary water law is strong on the issue of entitlement. However, it is not able to deal adequately with the problems of poverty alleviation and the environment.
2. The Statutory regime for the supply of water and sanitation in urban areas has been unable to deal adequately with the problems of entitlement, poverty alleviation, the environment and problems which women face when they collect water. Exception: The CWSP (Community Water & Sanitation Program) has been able to deal adequately with the problems of poverty alleviation and the role of women in water management. It has taken a realistic attitude towards the problem of entitlement. It has however been unable to deal with the environmental problem.”

RECOMMENDATIONS, summarized:

1. Optimize the extent to which the customary regime can be adapted to deal with the new problems that are coming up in the delivery of water and sanitation.
2. Optimize the capacities of the regulatory institutions that have been set up to manage water resources in Ghana.”

My Comment: not mentioned: the Heavy Metal Arsenic, or Mercury water contamination.

3a (ii). 2006 Minerals and Mining Act 703 - follow Mining Law ‘19, regulating (To Cite) Ownership of minerals and cadastral system, Mineral rights, Royalties, rentals, and fees, Reconnaissance license, Prospecting license, Mining lease, Radio-Active minerals commission, Surrender, suspension and cancellations of mineral rights, Surface rights and compensation, Industrial minerals commission, Small scale mining. My comment: The only provision concerning Heavy Metal Mercury: Purchase of mercury Art. 96. A small-scale miner may purchase from an authorized mercury dealer the quantities of mercury that may be reasonably necessary for the mining operations of the small-scale miner [7].

3a (iii) 2012 Minerals & Mining (Health, Safety, Tech Regulations: an extensive regulation of all activities concerned [8].

3a (iv) 2018 -11 WHO Guidelines Drinking Water Quality - 4th Edition - ’17 [9]:

To cite: “Summary: The Guidelines should be considered as ‘Law’, because of their supra-national character: Ghana is part of the World Health Organization. So Supra-national W.H.O.’s guidelines will be then incorporated in Ghana’s national law. In practice the guidelines are applied by G.W.C.L. s. table 19 and 22 of the 2015 -6 Summary - National Drinking Water Quality Management Framework for Ghana.

3a (v). 2018 Review of Customary Water Laws and Practices in Ghana (Author: A. Sarpong); Customary Water Laws and Practices: Ghana (per November 2018) [10]:

To CITE: Summary: (to quote) “The existing regime for regulation of water use is a mixture of customary rules and enactments according Article 11 of the 1992 Constitution on the sources of laws in Ghana. Article 11: the laws of Ghana shall comprise:

- The Constitution;
- Enactments made by or under the authority of the Parliament
- established by the Constitution:
 - Orders, Rules and Regulations made by any person or authority under a power conferred under the Constitution;
 - The Existing Law; and
 - The Common Law - art. 11(2), including Customary Law - art. 11(3): rules of law, which by custom, are applicable to particular communities in Ghana and, which
 - as to water - have been supplemented or supplanted by legislation:
 - Customary Rights and Practices,
 - Statutory Law and Customary Water Rights,
 - The Water Resources Commission Act, 1996, to establish the WRC, assigned: Specific functions of the WRC ... and Representation ... As a supplement to the WRC Act, the Government has adopted a Water Policy based on integrated water resource management, in order to achieve a sustainable management of the country’s water resources in consonance with the principle of sustainable development.

In the conclusion A. Sarpong mentioned, that “it is estimated that only 41.6 % of Ghanaians have access to potable water, and as many as 81% of the rural population in Ghana have NO access to potable water.

Ad 3b. The Ghana Environmental Policies concerning Water:

3b (i) 2016 Summary Review of Ghana’s Water Resource Management & Future [11]:

To CITE: “Objects of study

- the available water resources in Ghana (Basins-Ankobra, Densu, Pra, Tano and Volta),
- Water resource management in Ghana, incorporating IWRM (Integrated Water Resources Management) in Ghana,

- Challenges that the Ghana Water Commission is facing in the management of water and
- some recommendations that can help improve the management of water resources in Ghana: Recommendations into consideration:
- incorporating customary water management,
- renewable energy resource for mitigating climate change,
- investment in waste-water treatment,
- stakeholder specific responsibilities and
- increasing awareness of the dangers of illegal mining and education.”

3b (ii) 2018-8-2 Summary of Beyond the MDG (Millennium Development Goal) Ghana [12]:

To quote: “Conclusions:

- Ghana’s success in providing potable water to a good proportion of its population has been achieved (my comment: is +/- 60 % a ‘good proportion’? s. overview - Water Law by Sarpong, 2018 - 11).
- on the back of strong donor support and
- a strong and well organized institutional and policy framework. Nevertheless, the following threaten to unwind the progress made in the sector:
- the over-reliance on donors,
- poor cost recovery mechanisms in the rural and urban water sub-sectors,
- unbridled disposal of waste into water courses,
- widespread illegal mining activities, and
- inadequate and non-functional wastewater treatment facilities.”

3b (iv) GOV. INTENTIONS: L. 2018 -26-11 Summary Gov. develops new .. [13]:

To quote: “The Water Resources Commission has developed a Riparian Buffer Zone policy to develop and maintain buffers to conserve water bodies, Mr Enoch Teye Mensah, Minister of Water Resources, Works and Housing announced in Accra on Tuesday...to develop and maintain buffers to conserve water bodies, Mr Enoch Teye Mensah, Minster of Water Resources, Works and Housing announced in Accra on Tuesday.... He said such measures were being undertaken against the background that most rivers and water bodies in Ghana which used to be perennial were drying up. In addition, there was degradation of vegetative cover at headwaters and along the banks of many river systems and other surface water bodies all resulting from increase in human settlements, urbanization, poor agricultural practices and un-controlled logging and mining activities.” The Sector Minister said Ghana Water Company Limited (GWCL) mandated to provide safe, adequate and affordable water to urban population in the country operated 82 pipe-borne water systems with a total installed capacity of about 245 million gallons per day He said government had initiated some projects to improve the delivery of safe and affordable water in the country.”

My comment: and the Pra-basin as well, or: ‘to dirty’? The Western Region seems to be handled like a ‘hot ball’: better to throw it to some-one else! ... He said government had partnered DANIDA, International Development Association of the World Bank, Agence Francaise Development (AFD) and Canadian Development Agencies to fund many water-provision projects to address the challenges in water delivery in the country. Under the Rural Water Sub-sector, the sector minister said, government would provide funding from the Consolidated Fund for the delivery of 20,000 boreholes over a five-year period from 2011 to 2015 and that GH¢17 million had been provided this year for the drilling of the first batch of 1,090 boreholes. “To date, 400 boreholes have been drilled out of the revised target of 1,090 and work on the others was in progress,” Mr Mensah added.”

3c. Summary Ghana's Water & Sanitation Crisis - water.org [14]

To quote:

- “- close to six million people (nearly 22 %) rely on surface water to meet their daily water needs, leaving them vulnerable to water-related illness and disease.
- 67 % of Ghanaians lack access to improved sanitation or are entirely without toilet facilities;
- 70 % of all diseases in Ghana are caused by unsafe water and poor sanitation;
- The majority of households without access to safe water and sanitation lack the upfront funds needed to invest in their own solutions;
- Consequently, those living in poverty often pay up to ten times more per liter for water service from private vendors than their middle-class counterparts connected to piped water services. These water costs can be reduced through investments in improved household water assets such as connections, rainwater harvesting equipment, wells, and latrines. Unfortunately, this requires up-front investments that, without access to financing, are unrealistic for most of these people.”

4. My Comments to fore-mentioned studies:

a. Why in the Title: ‘Double Agenda’?

Because NOTHING in published facts has convinced the people in the Western Region, that anything has changed in the mining practices, since 2010:

- Galamsey practices have been continued in the Tarkwa area, due to the corruption of the local authorities, inclusive chiefs, the ‘Permit-Issuers’.
- Comparing two main Statistical Studies in resp. 2010 and 2017, seems, superficially looked at it, lead to the conclusion, (quote the Conclusion of the 2017 Study) “The general trend of water quality for the Tarkwa area is not as bad as previous studies have portrayed. “But, on a closer look, it turns out to lead to contrary conclusions which give reasons to criminal investigation of ‘Permit-Issuers’ and ‘Permit-Holders’, because:

1. See conclusion of the 2010 study: (quote) “This study underscores the value of multi-variate statistical analysis for evaluation and interpretation of the data with a view to stimulating better policy outcomes and decision-making that positively impacts water quality and thus prospectively diminishes the pollution caused by hazardous toxic elements in mining environments.” So, why decide to use a different Statistical method in 2017? In doing this, it is not possible to draw conclusions about improvement of the pollution of surface and ground-waters in the Tarkwa area, since 2010.
2. Another reason, why making statements about improvement is misleading, is, that the researchers, leave out research (and conclusions) about Mercury-measurements in the 2017 study. Which is, such as explained, intentionally, and very suspect for covering up the facts, because: according to the statement in the 2017 Study, quote “It also compared levels of metal concentration with those that were determined in previous research works, to identify changes that might have occurred”. And then, leave out ‘findings’ about Mercury!? Clearly, the 2010 Study advice to institute a Monitoring System was corrupted by the authorities in the Western Region! Further it shows the premise: for what you don’t investigate or do not report, you are not responsible: a fatal misstep, compromising all researchers involved.
3. The Ghana Medical Association made a statement in the Press about pollution of waters around the Tarkwa area, some years ago: which makes the Permit-Issuing authorities COMPLICIT: whilst knowing about the concern, still allowing continuation of the Galamsey practices in the Tarkwa Area.
4. Galamsey practice brings forth contamination of the surface- and ground-waters, especially with Hg: Quote Conclusion 2010 Study: “The use of mercury in gold mining by the Artisanal Small Scale Miners constitutes a point source of contamination” The local authorities in Tarkwa (AND those down-stream Bonsa-river-Ankobra-river and Pra-river systems) could know the facts:
- And because at least from 2014-November 2018, EXTENSIVE literature has been made available on the toxic effects of HM, esp. Hg, As, Pb and Cadmium on Human Health;

- and the World Health Organization stated in 2017, that Mercury is one of the most poisonous metals on earth, and published that year ALL effects and characteristics of Heavy Metals, those local authorities are so knowingly poisoning the population in Tarkwa, and surrounding areas! They don't care, because in doing so they ensure the continuing flow of revenues in corruptive transactions concerning illegal mining!

5. Outside the illegal Galamsey practices, Environmental practices of the Tarkwa Mine Concession holders (like Gold-field.com) or Concession extender (Tarkwa Mines) are obscured or compromised, because:

a. No data are made available about the HM concentration in the drainage waters from/close to the certified mines; with keyword: 'heavy metals in industrial waste water Tarkwa area': only a 2016 Research on Abatement of HM by charcoal (activated Carbon) [15]: disappointing for As (only 40 % absorbed) and, again: Hg not mentioned). Where may I else look for it?? Those data should be easily made available on Internet!!). Consequently, pollution with Heavy Metals in the Tarkwa Mine Area cannot be traced on the source of pollution (whilst in that area Galamsey is practiced). Unless the control on filtering at source is reliable! Which requires strict assessment and application of the law, which is clearly NOT happening now!

b. Outcomes of researches on HM concentrations in surface- or groundwater AFTER 2010 are dubious or false:

- because Multi-Variate Statistical Analysis is NOT applied on the samples - leading to false conclusions, when using a different Statistical Analysis;

- because in BOTH 2010 and 2017 studies less than 50 sampling bore-holes were allowed: for a reliable outcome you need at least 100 samples to do a Student t-test (to reach a credible outcome).

- because Undue Influence of the (lower) Authorities on the Research in that area is VERY likely (seen their interests in covering up facts): s. Ghana - 2013-Summary-Stakeholder-Analysis- Artisanal Gold Mining and Hg Contamination.pdf [2].

c. The 23 March 2021 W.H.O. guidelines update for Drinking-water - 4th Edition, demonstrates still the poisonous effects of mercury, lead, and arsenic containing drinking-water [23b];

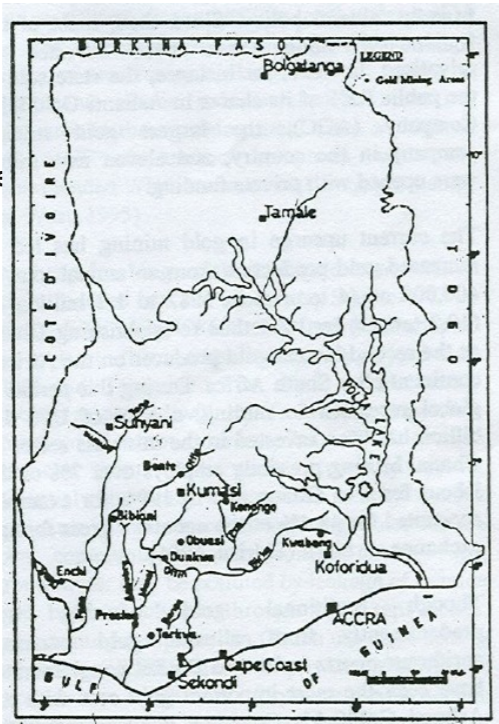
6. Why are the surrounding areas involved? By using <https://earthobservatory.nasa.gov/images/148376/detecting-gold-mining-in-ghana>, you can discover where gold-mining takes place, in Ghana [16]. The Ghana River Map with legends, combined with the table indicating mining-areas - gives an overview; all rivers drain from N -> S [17]

b. Drainage in River-systems from main Gold-Mines in Ghana:

Legend:
W.R. Western Region,
A.R. Ashanti Region,
E.R. Eastern Region

Enchi,	W.R. -->	Tano --->	Tano Lagoon (Cote d'Ivoire)
Bibiani,	W.R. -->		Ankobra
Prestea,	W.R. -->		Ankobra
Tarkwa,	W.R. -->		Ankobra
Dunkwa,	A.R. -->	Ofim -->	Pra
Bonte,	A.R. -->	Ofim -->	Pra
Obuasi,	A.R. -->	Ofim -->	Pra
Konongo,	A.R. -->		Pra
Kwabeng,	E.R. -->	Birim -->	Pra

Map of Main active Gold-mines in Ghana, today



A short explanation: **quote:** “The 2015 Ghana National Drinking Water Quality Management Frame-work [18], divides Ghana’s water resources potential into surface & ground-water sources. Surface water resources are mainly from: Three river systems that drain Ghana, namely: the Volta (with White Volta basin), South Western, and Coastal River systems. The South-Western river system is made up of the Bia Tano, Ankobra, and Pra rivers. Making up a total of 22% of Ghana’s land area. Five basins namely: Densu River basin, Ankobra basin, C. Pra basin, Tano basin and White Volta basin. The Pra basin is located between latitudes 50° N and 70° 30’N and longitudes 20° 30’W, and 00° 30’W in the south central of Ghana. The drainage network comprises the main Pra and its major tributaries of Birim, Anum and Offin rivers and their tributaries with a drainage area of about 22,06 km2, with an average elevation of about 300 m and generally less than 600 m above sea level. It features Lake Bosomtwe, which is a natural lake that stands out as prominent protected area (WRC Ghana, 2015).” The bare eye perceives there is something wrong with the water-quality of dirty-brown-coloured water of the river Pra. The Pipe-water is delivered by the GWCL, ONE of the Service Providers in the sense of the National Drinking Water Quality Management Framework for Ghana (June 2015). The other providers being the Private Sector Operators: Tankers, Self-suppliers and National Disaster Management Organization. The GWCL water source is the Pra, filtering it to potable water”.

c. The Role of the Drinking-water Sector Organizations in water management:
To CITE:

“The role of the Ghana Water Company in preserving the drinking water quality to Ghana Standards - within the National Drinking Water Quality Management Framework for Ghana of June 2015:
Ghana Water Company Ltd. (GWCL) was established by the Ghana Water and Sewerage Corporation Act of 1965, Act 310 to provide, distribute and conserve water for domestic, public and industrial purposes.
GWCL has a responsibility to deliver water quality that meets the Ghana Standards. In the years between then and 1994, it had responsibility for both urban and rural water supplies. GWCL has since 1999 been operating as a limited liability company following the enactment of the Statutory Corporations (converted to companies) Act 1993 (Act 461) (GOG, 1993a). GWCL operates 87 systems in Ghana” [18].

For the Role of other Drinking-water Sector Organizations: s. Appendix 7.2 Role and Responsibilities of drinking-water sector organizations

My Comments on the standards of Water Quality fixed by the National Drinking Water Quality Management Framework for Ghana of June 2015:

1. Even the National Drinking Water Quality Management Framework for Ghana of June 2015 does NOT subsume Arsenic under ‘Constituents of Health Significance’ (s. Appendix, Table 18);

2. Those Standards have been adopted from those of the W.H.O. Now, as to especially Hg and As, the ASSESSMENT-DATES ARE OUT-DATED: resp. 2011 and 2004;

3. One may argue: ‘I only drink water from sachets, so, not from the pipes of our Ghana Water Company (the only supplier of water through Government pipes): a wrong premise in the argument. Now, here is the catch or thorn in the flesh of the stake-holder (which is you, me and he, she, living in the Western Region): you are hooked, if you belief the sachet story: Because the quality of water from Tarkwa and river Pra is impaired at least from Galamsey practices, the Ghana Water Company had to RESTRICT its capacity (see recent Press-statements in 2017, see (2017-3) Summary-Ghana Western Region loses 5.3m gallons of water daily to Galamsey) [19]:

a. Price of water-units increased - not only as a result of limited supply (=rationing, the setting of proportions in water-supply), but - from the costs of filtering, as well: filtering comes with a price.

b. Uncertain quality of the water following, because it is NOT certain whether the GWC could filter out ALL toxic heavy metals.

c. The costs of water-filtering should be born by the polluter, cq the mining industries and individuals: not by Ghana’s Government.

- not only because the quality-standard of that water is required by law,

- but also because water is a primary commodity: the price-increase will react sharply to restriction of supply (an economic law)!

4. In the Public Interest, we are NOT at the end of the reasoning: to repeat what is summed up: s. (2018-11) Summary of Article - Ghana's Water & Sanitation Crisis [14]

“According to the Water.org:

- close to six million people (nearly 22 %) rely on surface water to meet their daily water needs ...

- 67 % of Ghanaians lack access to improved sanitation or are entirely without toilet facilities.

- 70 % of all diseases in Ghana are caused by unsafe water and poor sanitation!!

- That those living in poverty often pay up to 10 x more per liter water service. “

My comment: = equal to the costs of filtering saved by the illegal practices of illegal miners!! and s. (2018-11) Review of Customary Water Laws and Practices in Ghana [10]:

According to A. Sarpong: “an estimated 58.4 % of Ghanaians: NO access to potable water, and as many as 81% of the Rural population in Ghana: NO access to potable water.”

5. a. Following above reasons, the Medical Profession CANNOT deny the importance of the role of Irrigation in Healthcare provision in Ghana: water which is polluted with HM, is neither suitable for irrigation, because it serves to produce of food as well. See : research on HM Food Pollution in and down-stream the Tarkwa-area [20], and 2018 - 11- Mercury and Arsenic (in sea-food) - AACC.org [21]

b. Clean, streaming water reduces drastically water-born diseases!

c. The unrestricted mining activities in the Ankobra and Pra River Systems have caused increasingly more difficult to control: erosion and deforestation, corruption in mining activities, deterioration of the health-state of the population, with shortages of potable water, in those River Systems. And so cause in the end: a Water War ...

5. Conclusion

1. Generally, all uncontrolled Mining activities pose a hazard-risk for down-stream areas, populated or not. Consequently:
2. Authorities and Chiefs responsible for uncontrolled Mining activities, in the Tarkwa area, down-stream Bonsa river AND down-stream Pra River System, seem to collude. Acting like a Western Region Mafiosi which terrorizes the people of Ghana in the Western Region.
- They break the Fundamental Laws of Human Rights, because:
- a. Water is the FIRST elementary substance and requirement of the human body: eight glasses of (fresh) water required, in Africa, for normal body function of a grown-up, and
- b. the allowed Galamsey practice WITH obscured environmental practices of the Tarkwa Mines cause
- . rationing of pipe-water (by G.W.C.L.) and
- . leave the people of the Western Region in uncertainty about the quality of the pipe-water delivered by G.W.C.L. and put surface-water users at a life- hazard - (up to 81% of the Rural Population is dependent on the surface water, with mercury);
3. The lesson the miners have to take to heart: you CANNOT evade drinking-water (esp. HM caused) filtering costs;

5a. What has priority to be corrected or cleansed up?

- I. Transparency in mining practices and Ghana’s health-protective measures (in this case in ALL UP-STREAM Ankobra and Pra River systems! cq NOT only in Tarkwa). The Local Government and Public Health facilities are bound to that policy. Which may help to that effect:
- II. a. Institution of Water-Watch-Groups, as representatives of all stake-holders: a broader perspective of society than the construction mentioned in the Constitution of the Ghana Water Company (GWC);
- II. b. Replacement of the complete Club of assigned Inspectors.
- III. 1. Elimination of Arsenic in waste-water at source,
2. Reduction of all other toxic Heavy Metals in mining-waste-waters,
3. URGENT UPDATE to RECENT Scientific standards, by the GWC. See the case-study Asante Mining Area [24]. Why RECENT Scientific

standards? BECAUSE the W.H.O. showed great concern towards toxic effects of drinking-water and modified the standards of all HM according to the scientific state of affairs! s. W.H.O. Fact sheets Arsenic and Mercury, with Assessment dates, resp. updated in 2021 [23a, resp. 23b]; ASSESSMENT DATES of the 2017 Fact sheets were outdated: resp. 2011 (As) and 2004 (Hg)! IV. Any cover-up in this respect (s. the 2017 Research) constitutes:

a. A Breach of Ghana’s Constitution (Constitution of 1992 - 1996) Preamble (the protection and preservation of Fundamental Human Rights), Art. 37, clause 3 (Social Objective) [24]; U.N. Universal Declaration of Human Rights [especially art. 25 \(1\), \(2\)](#) [25], and Treaty of Rome [26].

b. Because poisoning with certain HM, especially Hg, As, Pb, Cad leads event-ually to undue increase of the price per water-unit and death of human beings, civil and criminal cases coincide and leading so to:

i. law-suites against the Polluters due to liability resp. ii. persecution of the Perpetrators due to criminality.

Since:

V. a. an attempt to solve above issues through a political process should be rejected, and assumed that the judiciary is not corruptible (which is not certain, seen the notorious High-Court procedures in relation to the election procedures concerning the last Mahama-Government);

b. the mining-industry and lower authorities are inert and passive in having shown no concerns about the toxic effects of Heavy Metals (in ground-water, surface water and drinking-water in the Tarkwa surrounding areas) and especially when they could evidently and purposely hide those effects for all stake-holders!!

A co-ordination between the Police Service, Armed Forces, Ghana Secret Service, and INTERPOL is imperative; considering that China in 2015 has been accused by African Union Officials of spying - through China-installed modems in AU Head Quarters; and so compromising the international position of the A.U.

VI. Further, I would urge the G.M.A. (Ghana Medical Association) to call in the advice of her stand-by (or ad-hoc) lawyer consultant group: to initiate, in co-operation with Governmental Lawyers, the court-procedures mentioned by consulting Chief-Justice. So, in principle improvising soil-breaking court-procedures, unique in Ghana.

VII. Dependent on the Constitution of the country, several articles may be the base for an appeal on Human Rights. For Ghana, is relevant:

- Ghana’s Constitution, Chapter 5 (Fundamental Human Rights & Freedoms) esp. Article 15, 17, 28 and 31 AND Part II Emergency Powers of the President should be called in:

VIII a. To reveal the real state of pollution, I advise to assign the research (in pollution by H.M. of ground-water, surface-water and pipe water of G.W.C. in the Tarkwa surrounding areas) to an independent Research-institute. The choice should fall especially and preferably on an Institute from a non-ex-colonial country. Why?

- to forestall prejudice by ‘incompatibilité des fonctions et des interests’,

- to save Ghana from disasters due to an unbridled mining-industry polluting ‘my people’ (to speak with ex-president Atta Mills).

- to honour the efforts and wishes of Ghana-founding President Nkrumah to promote irrigation for the whole of West Africa. ‘Irrigation’ meaning: affording water for agriculture, free from pollution by Heavy Metals caused by Mining-activities; ‘to serve ‘My People’, the farmers. The results of that research may serve as a solid base for proper Management of the G.W.C.L. cq WRC!

VIII b. For Management in cleaning up the surface-water resources for GWC-L, the identification of the gold-mines draining rivers Tano, Ankobra and Pra is significant. Because it will be of great help to introduce 3 Progress-Report system: an instrument to monitor the clean-up AND identify sources of pollution!

VIII c. INTRODUCE, AS SOON AS POSSIBLE, LAW-ENFORCED NON-TOXIC GOLD-WINNING!!

IX. Don’t forget: the interconnectivity of the river-systems in Africa poses now international politico-legal issues not known before:

Diplomacy or Court-procedures are needed to solve:

A. Trans-Boundary River Pollution Issues, OR

B. Issues caused by Water-restriction imposed by the neighbouring up-stream country / countries. Examples: ad A. PAST PRESENT (in 1999 already): the Water-restriction by a Burkina Faso Dam, followed by lowering of the water-level of the Volta-lake,

by which the newly built harbor in Yeji (Ghana Brong-Ahafo Region) became useless, caused by Burkina Faso. Diplomacy was virtually absent ... ad B. RECENT: Tano river H.M. pollution, caused by Ghana, to Cote d’Ivoire. Diplomacy was settled in an inter-state Commission.

X. IF the Message of this Presentation is falling in arid ground (not bearing fruit), the message will be brought to the WHOLE WORLD: through the Internet. POINT.

5b. And the Way Forward?

Are there Alternative Methods of Winning Gold available, other than those using the toxic Mercury or Cyanide? The answer is: YES!!

A. The Classical Gold Extraction Process:

(Wikipedia, January 4, 2019) Gold extraction refers to the processes required to extract gold * [27] from its ores ** [28] ... Gold mining from alluvium ores was once achieved by techniques associated with placer-mining ** [29], such as simple gold panning and sluicing, resulting in direct recovery of small gold nuggets and flakes. Placer mining techniques since the mid to late 20th century have generally only been the practice of artisan miners. (Google, May 15, 2013) Once the ore is mined it can be treated as a whole ore using a dump leaching or heap leaching processes. This is typical of low-grade, oxide deposits. Normally, the ore is crushed and agglomerated prior to heap leaching. The first step in this process is breaking down large chunks of rock into smaller pieces. ... Leaching dissolves, the gold out of the ore using a chemical solvent. Yet gold is tricky to extract, and contemporary methods include the use of a very icky (scientific term), highly toxic combination of cyanide salts. The cyanide leaches the gold out, but the cyanide seeps into the ground.

I. An article in Elsevier’s web-site gives the results of a Research in:

- Stakeholder Identification & Supply chains,
 - Stakeholder Identification in the Supply & Trade of Hg for the use in ASGM: s. 2016 - The mercury supply chain, stakeholders and their responsibilities in the quest for mercury-free gold [30].
- My comment: this research shows that, in order to regulate this Mercury Supply chain in Ghana - an URGENT elimination from ground-, surface-, and pipe-line water is necessary, by COMPULSARY LEGISLATION & STRICT EXECUTION. Because the stake-holder community is complex and multi-layered!

Mercury suppliers in Ghana:

- Tradeford mentions at least 24 suppliers and exporters of red mercury in Ghana],
- Tradeford: 9 suppliers of liquid mercury, and 4 buyers of liquid mercury,
- Tradeford: 7 suppliers of silver liquid mercury, 4 buyers of silver liquid mercury.

To cite: The mercury available on the world market is supplied from several different sources, including (not listed in order of importance):

1. Mine production of primary mercury (meaning extracted from ores within the earth’s crust):
 - a. either as the main product of the mining activity,
 - b. or as by-product of mining or refining of other metals (such as zinc, gold, silver) or minerals;
2. Recovered primary mercury from refining of natural gas (actually, a by-product, when marketed; however, it is not marketed in all countries);
3. Reprocessing or secondary mining of historic mine tailings containing mercury;
4. Recycled mercury recovered from spent products and waste from industrial production processes. Large amounts ("reservoirs") of
5. mercury are "stored" in society within products still in use and "on the users’ shelves";
6. Mercury from government reserve stocks, or inventories;
7. Private stocks (such as mercury in use in **chlor-alkali** and other industries), some of which may later be returned to the market.

Despite a decline in global mercury consumption (global demand is less than half of 1980 levels), supply from competing sources and low prices, production of mercury from mining is still occurring in a number of countries. Spain, China, Kyrgyzstan and Algeria have dominated this activity in recent years, and several of the mines are state-owned [31]

Example of Mining-Industry with a DUBIOUS MISSION: the Chinese Company Xin Hai, Mineral Processing EPC propagates (quote) “Artisanal and Small Scale Gold Mining Without Mercury (with the argument): The Minamata Convention on Mercury, a global agreement for reducing mercury pollution, recognizes the risks of using mercury in artisanal and small scale gold mining, and calls upon nations to reduce, and where feasible eliminate mercury use in this sector.” **At the same time** propagating a TOXIC method (quote) “Gold Cyanide Process is an efficient design of extracting and recovering gold from its ore. By cyaniding and carbon leaching crushed gold ore slurry simultaneously, this process would lower the gold mining operation cost and increase gold recovery rate to a degree of 99%.” with Tanzania as a success-story [32].

B. Examples of Toxic-free chemical Gold-Extraction Methods in use:

1. (Mother Nature Net, May 15, 2013) Researchers stumbled upon a method of a corn-starch chemical process: to replace toxic cyanide with plain old corn-starch: a clean, cheap method for extracting gold discovered by accident [33].

2. (The Metallurgist, January 4, 2019) mentions a free-gravity-borax method-GBM (gravity borax method) to Leach Gold Without Cyanide.

To quote: “This method basically requires the same equipment as the amalgamation methods. However, after the rod milling, an ore concentrate holding the heavy minerals is produced by using a launder (gold sluice) and a gold washing pan. The heavy mineral concentrate is mixed with borax powder. By blowtorching the mix, the borax melts, and the gold sinks to the bottom. It has recently been demonstrated that under identical conditions GBM yields more gold than the traditional amalgamation method. Despite this advantage, GBM is not widely used outside Benguet (Philippines). The Gravity-Borax Method GBM is still unknown to most Artisanal and small-scale gold miners (ASGMs) world-wide as most still use mercury to extract gold. Whole-ore amalgamation” is a technique that requires the use of 10-25 g of mercury to produce 1 g of gold. Within the last eight years, it has become evident that this technique is more widely used than earlier anticipated, and artisanal small-scale gold mining (ASGM) is now considered the single largest contributor to global mercury pollution with the environmental release of 2,000,000 lbs of mercury per year. The United Nations Environment Programme has estimated that ASGM contributes a 37% share of the anthropogenic emission of mercury to the atmosphere” [34].

C. Chemical-free methods of Gold-Extraction in use:

1. EXTRAC-TEC claims, **quote**, “- that Heavy Particle Concentration (HPC) technology enables cost-effective gravity separation of minerals of differing densities without the use of chemicals.

- recovery rates superior to any other equipment, minimizing losses and maximizing financial performance.

- to boast fine gold recovery rates of 95%-98% down to 50 microns by their system, based on their (revolutionary) patented transverse spiral concentrator belt and benefiting from almost 20 years of development experience.

to offer low, medium and high-capacity solutions for Alluvial and Hard Rock gold extraction as well as for other mineral recovery applications and for lead remediation of shooting ranges. See web-site <http://www.extrac-tec.com>” [35].

2. Rock-crushing machines, with many advertisements on-line, suitable for small-mining, and intermediate-large mining industries. Key-word: rock-crushing gold-mining machines;

3. Researchers find cyanide-free gold leaching process - Mining Magazine; **quote:** “As part of an eight-year study Curtin University researchers developed an improved glycine leaching technology that enhances the leaching rates for gold ore without using cyanide, a highly toxic chemical compound known to have detrimental effects on the environment and the human body. Typically, when leaching gold with glycine without cyanide miners need higher temperatures, glycine concentrations and oxygen addition levels. The Curtin process requires none of these [36].

So, what seems to be the way forward? Such as suggested, the methods - B1, B2, and B3, are suitable for Small-gold-mining and

- C1 or C2 may serve Intermediate and Large-gold-mining Industries, in Ghana (see above).
- What the Curtin process (C3) may bring, is still in research.

* Gold is a chemical element with the symbol Au (from Latin: aurum) and atomic number 79, making it one of the higher atomic number elements that occur naturally. In a pure form, it is a bright, slightly reddish yellow, dense, soft, malleable, and ductile metal. ... Gold is resistant to most acids, though it does dissolve in aqua regia (a mixture of nitric acid and hydrochloric acid), which forms a soluble tetra-chloro-a-urate anion.
<https://en.wikipedia.org/wiki/Gold>
** Ore is natural rock or sediment that contains one or more valuable minerals, typically containing metals, that can be mined, treated, and sold at a profit.
*** Placer mining / plæser, is the mining of stream bed (alluvial) deposits for minerals. This may be done by open-pit (also called open-cast mining), or by various surface excavating equipment or tunnelling equipment.

6. Epilogue:

The anecdote of the famous Odysseus is illustrative for the situation in the Western Region!
Odysseus was the Greek hero, who, after taking part in the Trojan war, landed by ship, with his comrades on an unknown island. They took refuge in a cave. Not knowing that this cave was the habitat of a Cyclops (One-eye, king in the country of the blind).
Unfortunately, some of his comrades were devoured by the Cyclops.
But: Odysseus managed with those left, to pierce a tree-stem in the eye of the Cyclops (which caused the Cyclops to be equal to his subjects ..). Whilst blocking the entrance of the cave, to control the sheep leaving, the Cyclops asked Odysseus about his name. He answered: my name is ‘nobody’ and consequently could escape with his comrades the cave, by imitating bleating sheep.
Now, WHAT is the parallel of this parable in this situation?

I landed in the Western Region as Nobody. And managed to escape from the cave with deadly polluted waters.

Who is the Cyclops (or One-eye in the country of the blind?) in the Western Region?

Answer: the colluding authorities which turn a blind eye to the dangerous Heavy Metal pollution in the Western Region and so covering up the danger (AND their own vision).

That God may continue to bless Ghana.

Reference-list:

[1] Impacts of Galamsey on Drainage and Sanitation-Tarkwa Mining communities; KWESI, Edward Attimo Amihyiah, APPIAH Sampson Tackyie, BORSAH, Issac, TAGGOE Naa Dedei, and TINADU Kwame, Ghana, FIG Working Week 2015, From the Wisdom of the Ages to the Challenges of the Modern World, Sofia, Bulgaria, 17-21 May 2015; PDF pp. 8 - 13;

[2] Artisanal Gold Mining and Mercury Contamination of Surface Water as a Wicked Socio-Environmental Problem: A Sustainability Challenge? Conference Paper · October 2013, DOI: 10.3390/wsf3-a002, Frederick Ato Armah 1,2*

[3] Anticorruption Methods & Tools W.M. UNDP-WWG (October 2011) commissioned by the UNDP, Website: www.undp.org/

[4] Mining and Heavy Metal Pollution: Assessment of Aquatic Environments in Tarkwa (Ghana) using Multivariate Statistical Analysis; See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/260793897>; Journal of Environmental Statistics February 2010, Volume 1, Issue 4. <http://www.jenvstat.org/>; Frederick Ato Armah, University of Cape Coast; Samuel Obiri, Centre for Environmental Impact Analysis; David Oscar Yawson, University of Cape Coast;

[5] Mining and Metal Pollution: Assessment of Water Quality in the Tarkwa Mining Area; Ghana Mining Journal, Vol. 17, No. 2, pp. 17 - 31; A. Ewusi, B. Y. Apeani, I. Ahenkorah and R. S. Nartey; cooperation between: University of Mines and Technology, P.O. Box 237, Tarkwa, Ghana; Technische Universität, Bergakademie Freiberg, Germany; Radford University College, Accra, Ghana.

[6] The Ghana Environmental Law & Policies concerning Water, The applicable law. 1999-8 Water Law, Water Rights and Water Supply (Africa) GHANA - country report, as an output from a project funded by Department for International Development (U.K.); Author: Kwadwo Mensah, Ghana; DFID KaR Project R7327, Dr. Peter Howsam, Reader (Groundwater Engineering and Water Policy & Law) Institute of Water and Environment Cranfield University at Silsoe, U.K.

[7] The 2006 Minerals and Mining Act 703; <https://resourcegovernance.org/sites/default/files/Minerals%20and%20Mining%20Act%20703%20Ghana.pdf>.

[8] The 2012 Minerals & Mining 9Health, Safety Technical Regulations; <http://extwprlegs1.fao.org/docs/pdf/gha168930.pdf>

[9] 2018 -11 WHO Guidelines Drinking Water Quality - '17; incorporating 1st addendum.pdf; WHO Library Cataloguing-in-Publication Data Guidelines for drinking-water quality: fourth edition incorporating the first addendum ISBN 978-92-4-154995-0

[10] November 2018 Review of Customary Water Laws and Practices in Ghana (Author: A. Sarpong). CUSTOMARY WATER LAWS AND PRACTICES PDF: GHANA (per November 2018).

[11] the Ghana Environmental Policies concerning Water: A review of Ghana’s water resource management and the future prospect; CIVIL & ENVIRONMENTAL ENGINEERING | REVIEW ARTICLE; Phebe Asantewaa Owusu, Samuel Asumadu-Sarkodie and Polycarp Ameyo; *Corresponding author: Samuel Asumadu-Sarkodie, Sustainable Environment and Energy Systems, Middle East Technical University, Northern Cyprus Campus, Guzelyurt, 99738 TRNC, Turkey; E-mail: samuel.sarkodie@metu.edu.tr
Reviewing editor: Shashi Dubey, Hindustan College of Engineering, India Cogent Engineering (2016), 3: 1164275; Received: 04 February 2016, accepted: 07 March 2016, Published: 28 March 2016;

[12] the Ghana Environmental Policies concerning Water: 2018-8-2, Beyond the MDG water target to universal water coverage in Ghana: the key transformative shifts required; Journal of Water, Sanitation and Hygiene for Development | 08.2 | 2018; a Review Paper; Isaac Monney (corresponding author) Department of Environmental Health and Sanitation Education, University of Education Winneba; Prince Antwi-Agyei NHance Development Partners Limited, Ghana;

[13] the Ghana Environmental Policies Water: GOV. INTENTIONS: 2018-26-11 Summary Government develops new policy to conserve water bodies; Resource Centre Network Ghana [14];

[14] 2018-11 Summary Ghana's Water & Sanitation Crisis - water.org; <https://water.org/our-impact/water-crisis/global-sanitation-crisis/> pp 1-2;

[15] Research on Abatement of Heavy Metals Concentration in Mine Waste Water Using Activated Carbons Prepared from Coconut Shells in a Gas-Fired Static Bed Pyrolysis/Activation Reactor*; Ghana Journal of Technology, Vol. 1, No. 1, pp. 46 - 52; Authors: Buah, W. K., Fosu S. and Ndur, S. A.; University of Mines and Technology, P.O. Box 237, Tarkwa, Ghana (September, 2016); https://www.researchgate.net/publication/309014179_Abatement_of_Heavy_Metals_Concentration_in_Mine_Waste_Water_Using_Activated_Carbons_Prepared_from_Coconut_Shells_in_a_Gas-Fired_Static_Bed_PyrolysisActivation_Reactor;

[16] <https://earthobservatory.nasa.gov/images/148376/detecting-gold-mining-in-ghana>

[17] Map of Main active Gold-mines in Ghana, today; <https://www.researchgate.net/profile/Raymond-Suglo-2/publication/272471074/figure/fig1/AS:294837434765314@1447306130278/Map-of-Ghana-showing-the-Location-of-the-Major-Gold-Mines.png>

[18] <https://www.gwcl.com.gh/company-profile/> AND http://www.gwcl.com.gh/national_drinking_water_quality_management_framework.pdf

[19] City 97.3 fm, cityfmonline, Western Region loses 5.3m gallons of water daily to galamsey - Water Company, March 22, 2017

[20] Research on HM Food Pollution in and down-stream the Tarkwa-area: Accumulation of Heavy Metals and Metalloid in Foodstuffs from Agricultural Soils around Tarkwa Area in Ghana, and Associated Human Health Risks; Authors: Nesta Bortey-Sam †, Shouta M. M. Nakayama †, Osei Akoto, Yoshinori Ikenaka, Julius N. Fobil, Elvis Baidoo, Hazuki Mizukawa, and Mayumi Ishizuka * Int. J. Environ. Res. Public Health 2015, 12, 8811-8827; doi:10.3390/ijerph120808811; International Journal of Environmental Research and Public Health; ISSN 1660-4601 www.mdpi.com/journal/ijerph; <http://europepmc.org/articles/PMC4555249>;

[21] 2018 - 11- Mercury and Arsenic (in sea-food) - ACC.org; <https://www.aacc.org/science-and-research/clinical-chemistry-trainee-council/trainee-council-in-english/pearls-of-laboratory-medicine/2011/heavy-metals>; Home// ... //TDM and Toxicology Division // Toxin Library // Mercury and Arsenic;

[22] Water-Pollution Research of Heavy Metals|2006-2007 - ENVIRONMENT AND HEALTH - Arsenic - Mercury a.o. Asante Region.pdf; ENVIRONMENTAL AND HEALTH IMPACT OF MINING ON SURROUNDING COMMUNITIES: A CASE STUDY OF ANGLOGOLD ASHANTI IN OBUASI; Joseph Yaw Yeboah B. A. (Hons.); A Thesis submitted to the Department of Geography and Rural Development, Kwame Nkrumah University of Science and Technology; August 2008

[23a] W.H.O. Fact sheets Arsenic and Mercury, with Assessment dates; <https://www.who.int/publications-detail-redirect/9789241549950>
[23b] W.H.O. guidelines update for Drinking-water - 4th Edition - Chemical Fact-sheet - 4add1-chap12.docx; https://cdn.who.int/media/docs/default-source/wash-documents/water-safety-and-quality/dwq-guidelines-4/gdwq4-with-add1-chap12.pdf?sfvrsn=25f9bc23_3

[24] Ghana’s Constitution (Constitution of 1992 - 1996) Preamble (the protection and preservation of Fundamental Human Rights).

[25] U.N. Universal Declaration of Human Rights especially art. 25 (1), (2); <https://www.un.org/sites/un2.un.org/files/udhr.pdf>

[26] Treaty of Rome, <https://www.europarl.europa.eu/about-parliament/en/in-the-past/the-parliament-and-the-treaties/treaty-of-rome>.

[27] <https://en.wikipedia.org/wiki/Gold>

[28] <https://en.wikipedia.org/wiki/Ore>

[29] https://en.wikipedia.org/wiki/Placer_mining

[30] The mercury supply chain, stakeholders and their responsibilities in the quest for mercury-free gold; Morgane M.C. Fritz a, n, Peter A. Maxson b, Rupert J. Baumgartner, University of Graz, Institute of Systems Sciences, Innovation and Sustainability Research, Merangasse 18/I, 8010 Graz, Austria b Concorde East/West Sprl, 10 Avenue René Gobert, 1180 Brussels, Belgium; Article history: Received 17 April 2016, received in revised form, 7 July 2016, Accepted 14 July 2016
Available online 14 October 2016.

[31] GreenFacts: Facts on Health and the Environment; <https://www.greenfacts.org/en/mercury/l-3/mercury-5.htm>.

[32] Chinese Company Xin Hai, Mineral Processing EPC; <https://www.linkedin.com/company/xinhai-mineral-processing-epc>.

[33] <https://www.popsoci.com/science/article/2013-05/cornstarch-replaces-cyanide-clean-new-gold-extraction-method/>; Popular Science, Cornstarch Replaces Cyanide In Clean New Gold Extraction Method, Scientists accidentally discover a new way to isolate gold that is much safer than existing processes, which use toxic cyanide; REBECCA BOYLE | PUBLISHED MAY 14, 2013 10:30 PM

[34] <https://www.911metallurgist.com/blog/mercury-free-gravity-borax-method-gbm>; AND [https://pubmed.ncbi.nlm.nih.gov/26463257/2016Feb;25\(4\):567-87](https://pubmed.ncbi.nlm.nih.gov/26463257/2016Feb;25(4):567-87). doi: 10.1177/1048291115607929. Epub 2015 Oct 13. Mercury Pollution from Small-Scale Gold Mining Can Be Stopped by Implementing the Gravity-Borax Method--A Two-Year Follow-Up Study from Two Mining Communities in the Philippines; Rasmus Køster-Rasmussen 1, Maria L Westergaard 2, Marie Brasholt 3, Richard Gutierrez 4, Erik Jørs 5, Jane F Thomsen 6; Affiliations expand PMID: 26463257 DOI: 10.1177/1048291115607929

[35] Home-page <http://www.extrac-tec.com>

[36] Rock-crushing machines, keyword: rock-crushing gold-mining machines

[37] <https://www.miningmagazine.com/>; Researches find cyanide-free gold leaching process with the Curtin process using glycine. 12-01-2021;

Appendix:

Standards of Water Quality fixed by the National Drinking Water Quality Management Framework for Ghana of June 2015: s. 7.1 Water Quality - Specification for drinking water FDGS 175-1:2013

Table 22 Inorganic constituents of health significance		
Cadmium (as Cd), max	0.003	mg/L
Lead (as Pb), max	0.01	mg/L
Mercury (total as Hg), max	0.001	mg/L

7.1 Water Quality - Specification for drinking water FDGS 175-1:2013
Table 19 Chemical requirements

Sr No.	Parameter	Requirement
1	Aluminium, (as Al), max	0.2 mg/L
2	Chloride (as Cl), max	250 mg/L
3	Iron (as Fe), max	0.3 mg/L
4	Manganese (as Mn), max	0.4 mg/L
5	pH	6.5 – 8.5*
6	Total dissolved solids	1000 mg/L
7	Sulphate (SO4), max	250 mg/L
8	Total hardness, max	500 mg/L
9	Arsenic (as As), max	0.01 mg/L
10	Residual free Chlorine*, max	0.2 mg/L
11	Cyanide (as CN), max	0.07 mg/L
12	Fluoride (as F), max	1.5 mg/L
13	Nitrite (as NO2), max	3.0 mg/L
14	Nitrate (as NO3), max	0.0 mg/L

*For effective disinfection, there should be a residual concentration of free chlorine of ≥ 0,5mg/L after at least 30min contact time at pH < 8,0
5 Prepared waters: water that may originate from any type of water supply

6 Waters defined by origin: waters that come from underground or from the surface (specific environmental resources) without passing through a community water system

7 Natural mineral water: microbiologically wholesome water originating in an underground water table or deposit and emerging from a spring

tapped at one or more exists and packed at source. It is clearly distinguished from ordinary drinking water by its natural (mineral content and trace-elements) by its original state. It is bottled or packaged at source and is recognized as a natural mineral water as specified in GS 220.

Table 22 Inorganic constituents in water, of health significance

1	Constituent	Requirement
2	Barium (as Ba), max.	0.7 mg/L
3	Boron (as B), max	0.5 mg/L
4	Cadmium (as Cd), max.	0.003 mg/L
5	Chromium (hexavalent), max.	0.05 mg/L
6	Lead (as Pb), max.	0.01 mg/L
7	Manganese (as Mn), max.	0.4 mg/L*
8	Mercury (total as Hg), max.	0.001 mg/L
9	Molybdenum, max.	0.07 mg/L
10	Nickel (as Ni), max.	0.02 mg/L
11	Selenium (as Se), max.	0.01 mg/L
12	Antimony (as Sb), max.	0.005 mg/L

*The concentration of the substance at or below this value may affect the appearance, taste or odour of the water leading to consumer complaints

7.2 Role and Responsibilities of drinking-water sector organizations

7.2.1 Policy Planning and Coordination

- Ministry of Water Resources Works and Housing (MWRWH)
- Ministry of Local Government and Rural Development
- Local Government Service Secretariat
- Ghana Health Service (GHS)/Ministry of Health (MOH) have responsibilities for ensuring good public health to the people of Ghana. The GHS/MOH role covers Advocacy, Advisory, Monitoring of Water related diseases.
- National Development Planning Commission
- Ghana Standards Authority (GSA)

7.2.2 Facilitation and Regulation

- **Water Resources Commission (WRC)** (Water Resources Commission) is established by the Water Resources Commission Act 522 **Invalid source specified.** to be responsible for the regulation and management of the utilization of water resources and for the co- ordination of any policy in relation to them. With respect to water quality their remit is on the raw water-surface and ground water- quality monitoring and surveillance. The **responsibilities** of WRC are to:
 - **propose** comprehensive plans for the utilization, conservation, development and improvement of water resources;
 - **initiate, control and co-ordinate** activities connected with the development and utilization of water resources;
 - **collect, collate, store and disseminate** data or information on water resources in Ghana;
 - **require** water user agencies to undertake scientific investigations, experiments or research into water resources in Ghana;
 - **monitor and evaluate** programs for the operation and maintenance of water resources;
 - **advise** the Government on any matter likely to have adverse effect on the water resources of Ghana;
 - **advise** pollution control agencies in Ghana on matters concerning the management and control of pollution of water resources; and
 - **perform** such other functions as are incidental to the foregoing.
- **Food and Drug Authority**
- **Community Water and Sanitation Agency**
- **Environmental Protection Agency (EPA) is established by the Environmental Protect Agency Act, 1994 Act 490 (GOG, 1994c)**
 - Advise the Minister on the formulation of policies on the environment and in particular to make recommendations for the protection of the environment;
 - Co-ordinate the activities of bodies concerned with the technical or practical aspects of the environment and serve as a channel of communication between those bodies and the Ministry;
 - Co-ordinate the activities of the relevant bodies for the purposes of con-trolling the generation, treatment, storage, transportation and disposal of industrial waste;
 - Secure by itself or in collaboration with any other person or body the control and prevention of discharge of waste into the environment and the protection and improvement of the quality of the environment;
- **Public Utilities Regulatory Commission**
- **District Assemblies (DAs)**

7.2.3 Service Providers

- **Ghana Water Company Limited:**
 - Ghana Water Company Ltd. (GWCL) was established by the Ghana Water and Sewerage Corporation Act of 1965, Act 310 to provide, distribute and conserve water for domestic, public and industrial purposes GWCL has a responsibility to deliver water quality that meets the Ghana Standards. In the years between then and 1994, it had responsibility for both urban and rural water supplies. GWCL has since 1999 been operating as a limited liability company following the enactment of the Statutory Corporations (Conversion to companies) Act 1993 (Act 461) (GOG, 1993a). GWCL operates 87 systems in Ghana.
- **Private Sector Operators: Tankers, Self-suppliers etc.**
- **National Disaster Management Organization**

7.2.4 Other Organizations: Universities, Research Institutes and NGOs:

- **Universities and Training Institutions** such as Kwame Nkrumah University of Science and Technology (KNUST), University of Cape Coast (UCC), University of Ghana (UG) conducts research and provides training in the areas of water supply.
- **The Water Research Institute:** Water Research Institute (WRI) one of the institutes of the Council for Scientific and Industrial Research (CSIR) was formed in 1996 from the merge of Institute of Aquatic Biology and the Water Resource Research Institute.